GEOTECHNICAL DESIGN REPORT

INTERSTATE 15 MANAGED LANES PROJECT, UNIT 4: FOUNDATION RECOMMENDATION FOR THE PROPOSED RETAINING AND SOUND WALLS

11-SD-15
PM M 14.3 / 15.3

11—080931

September 28, 2004

Prepared for:

District 11
Office of Design

By:

DIVISION ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design – South 2

State of California | Business, Transportation and Housing Agency

Memorandum

Flex Your Power!
Be energy efficient!

To: Mr. Gerard Chadergian
District 11
Office of Design, MS# 35

Date: September 28, 2004

File: 11-SD-15
PM M 14.3/15.3
EA 11 – 080931

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design – South 2

Subject: Interstate 15 (I-15) Managed Lanes Project Unit 4: Foundation Recommendations for the Retaining Walls RW14L, RW314R, RW317R, RW318R, RW320R, RW323R, and Sound Walls SW1 and SW2.

INTRODUCTION

In accordance with your request, a geotechnical investigation was performed for the purpose of providing foundation recommendations for the retaining structures that are required for construction of the I-15 Managed Lanes project, Unit 4. The investigation consisted of a site reconnaissance, a review of as-built plans and geologic maps, limited geologic mapping, a subsurface investigation that included drilling, sampling and soil samples testing, engineering analysis, and the writing of this report. The project information provided by the Project Engineer included walls' layout sheets in a scale of 1:1000 and pertinent cross sections, which were reviewed and used in the writing of this report.

PROJECT LOCATION

For the project location and its limits, reference is directed to Figure 1, Project Location. The project site is located in the City of San Diego, California. It generally involves the interchange between the north south trending Interstate 15, from Station 311+00 to 323+95 "SD15 M" Line and west east trending State Route 56, from Station 161+60 to 171+10 "56M" Line.

GENERAL

Table 1 on the following page lists the proposed retaining structures and indicates their station limits, types, and maximum heights. For detailed locations of the proposed walls, reference is directed to Attachment 1, Logs of Test Borings (LOTB's).

Table 1. Retaining Structures Data

WALL No.	BEGIN STATION	END STATION	ALIGNMENT	TYPE	MAXIMUM HEIGHT (m)
RW14L	168+38	170+27	BP	Type 1	9.1
RW314R	314+00	315+85	SD-15M	Type 1	7.3
RW317R	317+90	320+25	SD-15M	Type 1	6.1
RW318R	318+20	318+55	R4C	Type 1	2.4
RW320R	320+10	320+73	R4B	Type 1	2.4
RW323R	323+20	324+05	R4B	Type 1	7.3
SW1	320+56	321+33	SD-15M	Sound Wall	3.0
SW2	320+56	321+33	SD-15M	Sound Wall	3.1

GEOLOGY

The project site lies within the Peninsular Ranges Geomorphic Province of California. The project area is generally underlain by artificial fill, topsoil, and alluvium or a relatively thin mantle of residual soils. In addition, the southern section of the project site is underlain by the sedimentary lower Tertiary Friars Formation. The aforementioned stratigraphic units are underlain by a Mesozoic igneous and metamorphic rocks basement. The basement, the upper layer of which is weathered, is composed of upper Jurassic Santiago Peak Volcanics and mid Cretaceous granitic rocks of the Southern California Batholith. (Kennedy and Peterson, 1975).

The Santiago Peak Volcanics rocks range in composition from basalt to rhyolite, but are predominantly dacite and andesite. They include a variety of breccia, agglomerate, volcanic conglomerate, and fine-grained tuff-breccia. In addition, they include a number of small plutons of mildly metamorphosed gabbro. The Santiago Peak Volcanics are hard-and extremely resistant to erosion and form topographic highs. Most of the volcanic rocks are dark greenish gray where fresh, but weather grayish red to dark reddish brown. The residual soil developed on the Santiago Peak Volcanics has the color of weathered rock and supports the growth of dense chaparral. Plutonic rocks of the Southern California Batholith within the project area are

quartz diorite and gabbro. These granitic rocks are strongly weathered often with spheroidal boulders as a result of weathering (Kennedy and Peterson, 1975). The residual soil developed on the granitic basement consists of sands often with preserved remnant texture of the parent rock. Based on the geologic literature and our subsurface investigation program, it appears that most of the project site is located at about the contact between the granitic Southern California Batholith and Santiago Peak Volcanics geologic units.

The Friars Formation consists of siltstone and sandstone with interbeds of claystone. Landslides and surficial slipouts are common in the clay-rich part of the formation that is exposed on slopes in the hilly topography. The southern section of the project site is underlain by the Friars Formation. In addition, from about Station 312+80 to the southern limit of the project site, during the construction of the I-15 freeway (in 1982), two stabilization embankments (buttresses) were constructed in order to stabilize cuts made into the slopes built of the soils of the Friars Formation. The removal of these buttresses or their sections could potentially adversely affect the stability of the aforementioned existing cut slopes (Caltrans As Built Plans, Contract No. 11-105624, 1982).

Alluvium consists primarily of stream deposits of clay, silt (often clayey), sand, and gravel derived from bedrock and residual sources that lie within or near the project area. Artificial fill consists of compacted earth materials derived from local sources.

SEISMICITY

No known Holocene fault exists within the project area. The nearest known active fault is the Rose Canyon Fault Zone believed to be capable of producing an earthquake with a Maximum Credible Magnitude of 7.0 on the Richter scale. It is located about 16 km southwest and west from the project site. The La Nacion Fault is located about 19 kilometers south from the project limits, and it is capable of producing an earthquake with a Maximum Credible Magnitude of 6.75 on the Richter scale. In addition, the Elsinore Fault lies about 40 km northeast from the project limits; it is capable of producing an earthquake with a Maximum Credible Magnitude of 7.5 on the Richter scale. All three aforementioned faults are believed to be capable of generating a Peak Ground Acceleration of about 0.25 g at the project site (Mualchin, 1996).

GROUNDWATER

Groundwater was not encountered during our subsurface investigations for the subject retaining structures. However, groundwater conditions, mainly perched water could potentially occur at isolated locations during the construction phase of the project. In general, the occurrence of perched water is not likely to have a significant impact on construction of the walls. In the event that groundwater is encountered during construction, groundwater mitigation recommendations will be provided by this office.

CORROSION

Several soil samples were collected from the location of the subject retaining structures. These samples were tested at Caltrans District 11 Transportation Laboratory for corrosive potential and found to be non corrosive. The results of the corrosivity tests are presented in Table 2 below.

Table 2. Results of Corrosivity Tests

BORING No.	SAMPLE DEPTH (m)	pH	MINIMUM RESISTIVITY (ohm-cm)	SULFATE CONTENT (ppm)	CHLORIDE CONTENT (ppm)
RW14L-B2	2.4-3.0	N/A	2,450	N/A	N/A
RW314R-B2	0-1.5	7.7	1,500	42	60
RW317R-B2	1.5-3.0	7.8	1,300	56	90
RW12R-B3*	1.5-3.0	N/A	2,200	N/A	N/A

* -- This test result applies to Walls RW318R and RW320R

Note: Caltrans defines a corrosive area as an area where the soil and/or water contains more than 500 ppm of chlorides, more than 2000 ppm sulfates, has a minimum resistivity of less than 1000 ohm-cm, or a pH of 5.5 or less.

Based on the laboratory corrosivity test results performed in 2000, for the nearby Ted Williams Parkway Overcrossing Tieback Walls project and the results of the corrosivity tests for Wall RW14L the soils along the alignment of the proposed Wall RW323R are deemed to be non corrosive (Rogers, 2000).

FOUNDATION RECOMMENDATIONS

Retaining Wall RW14L

Subsurface Soil Conditions

Wall RW14L is planned to retain a major cut into the slope of the existing road embankment that is about 16 m in maximum height. Based on the subsurface investigation, this road embankment is built of fill materials. Fill consists of a mixture of gravel and cobble-sized rocks of the Santiago Peak Volcanics origin, silty clay, sandy silt, and sand. Locally this fill grades to intensely gravelly and cobbly. Based on SPT blow counts, the relative density of fill granular materials was found to be medium dense and the relative consistency of cohesive materials was determined to be stiff. However, during the subsurface exploration several zones/layers composed of gravel and cobble-sized rocks within relatively loose silty and sandy matrix were encountered.
Fill materials are expected to be underlain by the topsoil that in turn is underlain by the

weathered granitic bedrock.

For Wall RW14L LOTB's RW14L-B1 and RW14L-B2 were developed and submitted to the Project Engineer.

Foundation Recommendations

Based on the subsurface investigation, the review of geologic references and engineering analyses, it is recommended that Wall RW14L, 9.1 m in maximum height, may be designed as standard Type 1 wall, supported on a spread footing foundation as shown on sheet B3-1 in the "Standard Plans July 1999". With Loading Case I, the 300 kPa Gross Allowable Soil Bearing Pressure may be used for design of the Wall RW14L. For the wall height greater than 4.8 m the minimum distance from the edge of the footing to the face of the descending slope should be no less than 2.4 m. For the wall height less than 4.8 m this minimum distance should be no less than 1.5 m. In addition, it is recommended that along the entire alignment of Wall RW14L the 1.5 m thick layer of existing fill materials be removed from under the bottom of the proposed footing and replaced with structural backfill compacted to 95 % Relative Compaction in accordance with CTM 216.

Global Slope Stability

Based on cross-sections provided by your office, global slope stability analyses were performed using the StedWin (GSTABL7) computer program to determine the overall stability of the new cut slope retained by Wall RW14L. The calculated Modified Bishop Safety Factor for the proposed new cut slope is 1.7, which is considered acceptable.
The slope stability analyses output data (graph) is presented in Attachment 2, Wall RW14L: Slope Stability Analysis Results.

Construction Considerations

Based on the results of the subsurface investigation, local experience, and the review of geologic references, it is anticipated that excavations for Wall RW14L foundations will be accomplished with the use of standard (heavy) earthwork equipment.

Retaining Wall RW314R

Subsurface Soil Conditions

The alignment of Wall RW314R is planned to traverse the east-facing slope of the existing road embankment built of fill materials that is about 8 m in maximum height. The widening of this embankment will involve the placement of new fill on the existing embankment slope and retaining it with the proposed Wall RW314R. Drilling at the exact location of the wall alignment was not feasible; thus, it was not conducted. However, it is anticipated that the

existing embankment fill materials consist of a mixture of gravel and cobble-sized rocks of the Santiago Peak Volcanics origin, silty clay, sandy silt, and sand.
Fill materials are expected to be underlain by the fill and/or topsoil that in turn is underlain by the native soils of the Friars Formation consisting of silty sand and/or silty sandstone.

For Wall RW14L LOTB RW314R-B1 was developed and submitted to the Project Engineer.

Foundation Recommendations

Based on the subsurface investigation, the review of geologic references and engineering analyses, it is recommended that Wall RW314R, 7.3 m in maximum height, may be designed as standard Type 1 wall, supported on a spread footing foundation as shown on sheet B3-1 in the "Standard Plans July 1999". With Loading Case I, the 235 kPa Gross Allowable Soil Bearing Pressure may be used for design of the Wall RW314R. The minimum distance from the edge of the footing to the face of the descending slope should be no less than 1.5 m. In addition, it is recommended that along the entire alignment of Wall RW314R the 1.5 m thick layer of existing fill materials be removed from under the bottom of the proposed footing and replaced with structural backfill compacted to 95 % Relative Compaction in accordance with CTM 216.

Global Slope Stability

Based on cross-sections provided by your office, global slope stability analyses were performed using the StedWin (GSTABL7) computer program to determine the overall stability of the new fill slope retained by Wall RW314R. From about Station 315+77 to 315+85, the existing embankment slope is inclined at about 1:1.5 (V:H). Within this section, the calculated Modified Bishop Safety Factor for the proposed new embankment (retained by Wall RW314R) is 1.4, which is considered marginally acceptable. However, from Station 314+00 to 315+77 the aforementioned embankment slope is inclined at 1:2 (V:H). Consequently, for the 1:2 (V:H) slope configuration the calculated Modified Bishop Safety Factor for the proposed new embankment (retained by Wall RW314R) is 1.6, which is considered acceptable.
The slope stability analyses output data (graphs) is presented in Attachment 2, Wall RW314R: Slope Stability Analysis Results.

Construction Considerations

Based on the results of the subsurface investigation, local experience, and the review of geologic references, it is anticipated that excavations for Wall RW314R foundations will be accomplished with the use of standard (heavy) earthwork equipment.

Retaining Wall RW317R

Subsurface Soil Conditions

Wall RW317R is planned to be constructed in conjunction with the MSE 1 Retaining System. From Station 315+00 to 319+22, the MSE 1 Retaining System is to retain the western limits of the planned road embankment, and from Station 317+90 to 320+25, Wall RW317R is to retain the eastern limits of this embankment. Foundation recommendations for the MSE 1 Retaining System were included in the foundation report issued to the Office of Structures Design on April 14, 2004, and titled: "*Interstate 15 Managed Lanes Project, Unit 4: Foundation Recommendations for the MSE 1 Retaining System, Retaining Wall RW317R, and RW12R.*"

The entire length of the Wall RW317R alignment is currently underlain by a layer of fill materials that is variable in thickness. The fill is underlain by topsoil and/or alluvial soils that in turn are underlain by the weathered bedrock. Fill materials consist of gravelly clays and silts with sand. The alluvium consists of silty clays, often fat (highly plastic).

For Wall RW317R LOTB's RW317R-B1 and RW317R-B2 were developed and submitted to the Project Engineer. In addition, LOTB's MSE1-B4 and MSE1-B5 attached to the aforementioned foundation report issued to the Office of Structures Design (page R-114) could be utilized for Wall RW317R.

Foundation Recommendations

Based on the subsurface investigation, the review of geologic references and engineering analyses, it is recommended that Wall RW317R, 6.1 m in maximum height, may be designed as standard Type 1 wall, supported on a spread footing foundation as shown on sheet B3-1 in the "Standard Plans July 1999". With Loading Case II, the 225 kPa Gross Allowable Soil Bearing Pressure may be used for design of the Wall RW317R. The minimum distance from the edge of the footing to the face of the descending slope should be no less than 1.5 m.

It is my understanding that from Station 317+90 to about Station 318+40, the footing of Wall RW317R will be placed on a layer of structural backfill (associated with the construction of MSE 1 Wall) compacted to 95% of Relative Density in accordance with CTM 216. Therefore, along this section of the wall alignment no improvement of soils under the bottom of proposed footing is recommended.
From about Station 318+40 to about Station 318+40 the footing of Wall RW317R will be embedded in the existing fill materials. Therefore, it is recommended that along this section of wall alignment the 1.5 m thick layer of existing fill materials be removed from under the bottom of the proposed footing and replaced with structural backfill compacted to 95 % Relative Compaction in accordance with CTM 216.
From Station 319+60 to 320+30, no improvement of soils under the bottom of proposed footing is recommended.

Construction Considerations

Based on the results of the subsurface investigation, local experience, and the review of geologic references. it is anticipated that excavations for Wall RW317R foundations will be accomplished with the use of standard (heavy) earthwork equipment.

Retaining Wall RW318R

Subsurface Soil Conditions

Based on the subsurface investigation conducted for the nearby structures and a review of the geologic references. the alignment of the proposed retaining Wall RW318R is expected to be underlain by fill materials consisting of sands and gravelly silts and clays. In addition, it is my understanding that sections of the footing of Wall RW318R are planned to be located above the existing grade. Therefore, they will be embedded in new fill materials placed on the existing grade.

Foundation Recommendations

Based on the subsurface investigation, the review of geologic references and engineering analyses. it is recommended that Wall RW318R, 2.4 m in maximum height, may be designed as standard Type 1 wall, supported on a spread footing foundation as shown on sheet B3-1 in the "Standard Plans July 1999". With Loading Case I, the 105 kPa Gross Allowable Soil Bearing Pressure may be used for design of the Wall RW318R. In addition, it is recommended that along the entire alignment of Wall RW318R, under the bottom of the proposed footing, the 0.9 m thick layer of the existing fill materials should be recompacted to 95 % Relative Compaction in accordance with CTM 216. Also, any new fill to be placed under the bottom of the proposed footing should consists of structural backfill compacted to 95 % Relative Compaction in accordance with CTM 216.

Construction Considerations

Based on the results of our subsurface investigation, our local experience, and the review of geologic references, we anticipate that excavations for Wall RW318R foundations may be accomplished with the use of standard earthwork equipment.

Retaining Wall RW320R

Subsurface Soil Conditions

Based on the subsurface investigation conducted for the nearby structures and a review of the geologic references. the alignment of the proposed retaining Wall RW320R is expected to be

underlain by fill materials consisting of sands and gravelly silts and clays.

Foundation Recommendations

Based on the subsurface investigation, the review of geologic references and engineering analyses, it is recommended that Wall RW320R, 2.4 m in maximum height, may be designed as standard Type 1 wall, supported on a spread footing foundation as shown on sheet B3-1 in the "Standard Plans July 1999". With Loading Case I, the 105 kPa Gross Allowable Soil Bearing Pressure may be used for design of the Wall RW320R. In addition, it is recommended that from Station 320+10 to 320+35, under the bottom of the proposed footing, the 0.9 m thick layer of the existing fill materials should be recompacted to 95 % Relative Compaction in accordance with CTM 216.

Construction Considerations

Based on the results of our subsurface investigation, our local experience, and the review of geologic references, we anticipate that excavations for Wall RW320R foundations may be accomplished with the use of standard earthwork equipment.

Retaining Wall RW323R

Subsurface Soil Conditions

Wall RW323R is planned to retain a major cut into the slope of the existing road embankment that is about 14 m in maximum height. Based on the subsurface investigation, this road embankment is built of fill materials. Fill consists of a mixture of gravel and cobble-sized rocks of the Santiago Peak Volcanics origin, silty clay, sandy silt, and sand. Locally this fill grades to intensely gravelly and cobbly. Based on SPT blow counts, the relative density of fill granular materials was found to be medium dense and the relative consistency of cohesive materials was determined to be stiff. However, during the subsurface exploration several zones/layers composed of gravel and cobble-sized rocks within relatively loose silty and sandy matrix were encountered.
Fill materials are expected to be underlain by the topsoil that in turn is underlain by the weathered granitic bedrock.

For Wall RW323R LOTB's RW323R-B1 and RW323R-B2 were developed and submitted to the Project Engineer.

Foundation Recommendations

Based on the subsurface investigation, the review of geologic references and engineering analyses, it is recommended that Wall RW323R, 7.3 m in maximum height, may be designed as standard Type 1 wall, supported on a spread footing foundation as shown on sheet B3-1 in the

"Standard Plans July 1999". With Loading Case I, the 235 kPa Gross Allowable Soil Bearing Pressure may be used for design of the Wall RW323R. For the wall height greater than 4.8 m the minimum distance from the edge of the footing to the face of the descending slope should be no less than 2.4 m. For the wall height less than 4.8 m this minimum distance should be no less than 1.5 m. In addition, it is recommended that along the entire alignment of Wall RW323R the 1.5 m thick layer of existing fill materials be removed from under the bottom of the proposed footing and replaced with structural backfill compacted to 95 % Relative Compaction in accordance with CTM 216.

Global Slope Stability

Based on cross-sections provided by your office, global slope stability analyses were performed using the StedWin (GSTABL7) computer program to determine the overall stability of the new cut slope retained by Wall RW323R. The calculated Modified Bishop Safety Factor for the proposed new cut slope is 1.9, which is considered acceptable.
The slope stability analyses output data (graphs) is presented in Attachment 2, Wall RW323R: Slope Stability Analysis Results.

Construction Considerations

Based on the results of the subsurface investigation, local experience, and the review of geologic references, it is anticipated that excavations for Wall RW323R foundations will be accomplished with the use of standard (heavy) earthwork equipment.

Sound Wall SW1

Subsurface Soil Conditions

Based on the subsurface investigation conducted for the nearby structures the entire length of the Sound Wall SW1 alignment is expected to be underlain by a layer of fill materials that is variable in thickness. The fill is underlain by topsoil and/or alluvial soils that in turn are underlain by the weathered bedrock. Fill materials consist of gravelly clays and silts with sand. The alluvium consists of silty clays, often fat (highly plastic).

Foundation Recommendations

Based on the subsurface investigation, the review of geologic references and engineering analyses, it is recommended that Sound Wall SW1, 3.0 m in maximum height, may be designed as standard Masonry Block (wall), supported on a trench footing foundation as shown on sheet 3-66 in the "Bridge Standard Details Sheets, April 2000". With Case 2, the 30-degree of the angle of internal friction of the subsurface soils may be used for design of the trench footing for Sound Wall SW1.

Construction Considerations

Based on the results of the subsurface investigation, local experience, and the review of geologic references, it is anticipated that excavations for Sound Wall SW1 foundations will be accomplished with the use of standard earthwork equipment.

Sound Wall SW2

Subsurface Soil Conditions

Based on the subsurface investigation conducted for the nearby structures the entire length of the Sound Wall SW2 alignment is expected to be underlain by a layer of fill materials that is variable in thickness. The fill is underlain by topsoil and/or alluvial soils that in turn are underlain by the weathered bedrock. Fill materials consist of gravelly clays and silts with sand. The alluvium consists of silty clays, often fat (highly plastic).

Foundation Recommendations

Based on the subsurface investigation, the review of geologic references and engineering analyses, it is recommended that Sound Wall SW2, 3.1 m in maximum height, may be designed as standard Masonry Block (wall) on Type 7365/SV Barrier, supported on a pile foundation as shown on sheet 3-65 in the "Bridge Standard Details Sheets, April 2000". With Case 2, the 32-degree of the angle of internal friction of the subsurface soils may be used for design of the pile foundation for Sound Wall SW2.

Construction Considerations

Based on the results of the subsurface investigation, local experience, and the review of geologic references, it is anticipated that excavations for Sound Wall SW2 foundations will be accomplished with the use of standard earthwork equipment.

If you have any question or comments regarding this Geotechnical Design Report, please call Jeff Tesar at (858) 467-2716 (Calnet 734-2716).

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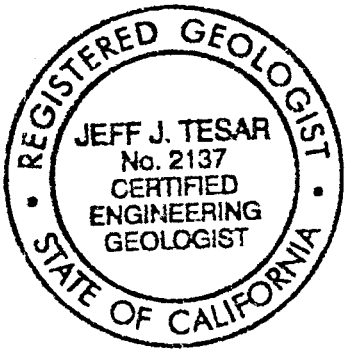

Figures

1. Project Locaton

Attachments

1. Logs of Test Borings
2. Slope Stability Analysis Results (Graphs)

References:

1. L. Mualchin, California Seismic Hazard Map, 1996.
2. Michael P. Kennedy and Gary L. Peterson, Geology of the San Diego Metropolitan Area, California, Poway Quadrangle, California Division of Mines and Geology, Bulletin 200, 1975.
3. Caltrans, As Built Plans Contract No. 11-105624, 1982.
4. M. Rogers, Ted Williams Overcrossing, Tieback Walls W-1 and W-2, Final Foundation Recommendations, August 10, 2000.
5. J. Tesar and B. Hinman, "Interstate 15 Managed Lanes Project, Unit 4: Foundation Recommendations for the MSE 1 Retaining System, Retaining Wall RW317R, and RW12R," April 14, 2004.